MEETING AGENDA

Wednesday:

1:00 PM Introductions and project review - *Bob Bea*

1:30 TOPCAT Enhancements I (Earthquake Analyses) - *Jim Stear*

2:30 Break

2:45 TOPCAT Enhancements II (Modification in spatial loading effects, diagonal loading analysis, long-term accumulative reliability, deck element analysis) - *Zhaohui Jin*

4:30 Discussions

5:00 PM Adjourn

Thursday

8:00 AM Review issues from previous day - *Bob Bea*

8:30 Verification of wave force on deck modules - *Rune Iverson*

9:30 Verification of Cnoidal wave kinematics & forces Modules - *Rune Iverson*

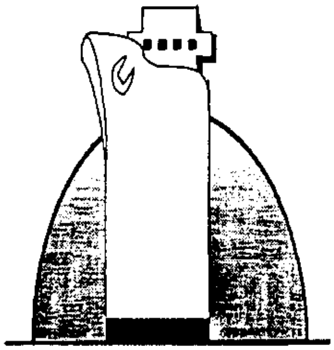
10:30 Break

10:45 TOPCAT Licensing Status: *Dave Hall*

11:00 TOPCAT Future Work: Spring 99 work plan – *Bob Bea, Jim Stear, Zhaohui Jin*

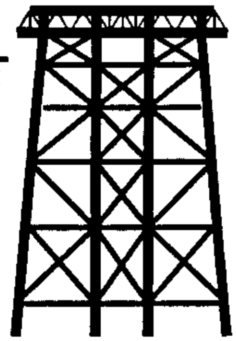
11:30 Discussions

12:00 Adjourn



1998 – 1999

MARINE TECHNOLOGY & MANAGEMENT GROUP



INDUSTRY & GOVERNMENT AGENCIES SPONSORED RESEARCH PROJECTS SUMMARIES

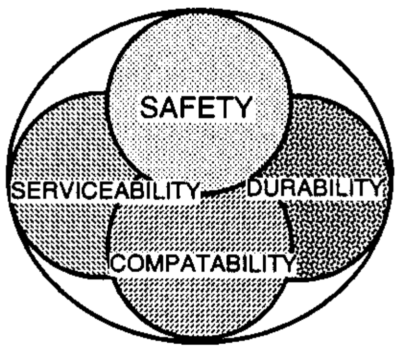
Professor Robert Bea
College of Engineering
Tel: (510) 642-0967
Fax: (510) 643-8919
e-mail: rgbea@euler.berkeley.edu

Professor Karlene Roberts
Haas School of Business
Tel: (510) 642-5221
Fax: (510) 631-0150
e-mail: karlene@haas.berkeley.edu

215 McLaughlin Hall
UNIVERSITY OF CALIFORNIA
Berkeley, CA 94720-1712

Goal: Develop engineering and management technology that will help improve the QUALITY (safety, serviceability, durability, compatibility - economy) of marine systems

QUALITY



RESEARCH AREAS

Human & Organization Factors
Ships & Floating Systems
Platforms & Pipelines

Human and Organization Factors	Researcher	Goals and Objectives
Human & organization factors in diving operations	Lt. Timothy Liberatore	Promote dive safety through identification, analysis, and management of human and organization factors in diving operations.
Human & organization factors in quality of offshore platforms	Lt. Richard Lawson	Develop and apply a computer program to facilitate analyses of human and organizational factors in the life-cycle quality performance of off-shore platforms
Safety Managemen t Assess-ments in Ship Operations: Human and Organizational Factors	Lt. Paul Szwed Lt. Jason Tama	Develop, verify, and test a protocol and computer program to help per-form ship operations Safety Management Assessments (ISM, International Safety Management, Code) with a focus on Human and Organizational Factors
Human and Organizational Factors in Reliability of Marine Systems	Bob Bea	Develop and assist in implementation of proactive, reactive, and real-time measures in design engineering of marine systems to improve hu-man and organizational factors in the life-cycle reliability of these systems

Ships, Platforms, Pipelines	Researcher	Goals and Objectives
Design and construction of long-life marine composite structures: fatigue	Paul Miller	Develop and test panels of marine composites subjected to repeated loadings in submerged conditions. Develop and verify an analytical procedure to allow the evaluation of the long-term performance charac-teristics of marine composite panels.
Optimal strategies for life cycle IMR (Inspections, Mainte-nance, Repair) programs for marine systems	Assignment Pending	Develop procedures and strategies to optimize the inspection, mainte-nance, and repair of offshore platform structures and marine pipelines. The inspection strategies will address predictable damage (e.g. fatigue of critical structural details) and unpredictable damage (e.g. due to acci-dents and errors).
Ultimate Limit State Limit Equi-librium Analyses of template-type offshore platforms - ULSLEA Phases 4 and 5	Jim Stear, Zhaohui-Jin,	Continue development and verification of a simplified procedure to characterize the ultimate limit state loadings and capacities of offshore platforms and their reliabilities for extreme condition storms and earth-quakes.
Performance of pile founda-tions subjected to earthquake excitations (Profs. Seed, Bray, Pestana)	Philip Meymand, Thomas Lok, Chris Hunt	Develop and verify analytical models to assess the performance charac-teristics of groups of piles supporting structures subjected to intense earthquake excitations. Perform shaking tests on model pile groups to provide test data to verify the analytical models.
Pipeline Integrity and Maintenance Information Sys-tem - PIMPIS	Botond Farkis	Develop and verify an inspection and maintenance decision support system for submarine pipelines using a knowledge-based approach. PIMPIS will provide a means of embedding expert knowledge to help select options for pipeline inspections and maintenance.

Ships, Platforms, Pipelines	Researcher	Goals and Objectives
Platform, pipeline, and floating systems design and requalification criteria for the Bay of Campeche and offshore Tampico - Tuxpan	Dr. Tao Xu, Zhaohui-Jin	Develop and verify a general platform and pipeline design and reassessment - requalification system tailored to the unique environmental, operational, and economic characteristics of PEMEX operations in the Bay of Campeche and offshore Tampico and Tuxpan.
Pipeline design criteria for second trunkline North West Shelf Australia	Bob Bea	Develop risk based deformation - strain stability criteria for a 48-inch diameter gas pipeline offshore North West Shelf Australia
ISO earthquake guidelines for design and reassessment of offshore platforms	Bob Bea	Continue development of reliability based platform earthquake design and reassessment guidelines for the International Standards Organization.
Reliability based earthquake LRFD design guidelines for offshore Indonesia	Bob Bea	Develop oceanographic and earthquake platform load and resistance factor design guielines for offshore Indonesia
Decommissioning and re-use of offshore platforms	James Wiseman	Evaluate and document rigs-to-reef alternatives for decommissioning platforms offshore California
Wave loadings on decks of offshore platforms - laboratory data verifications	Rune Iversen	Verify Modified API wave in deck force guidelines with results from laboratory tests
Simplified Analyses of Deep Water Floating Systems (SADWFS)	Assignments Pending	Develop, program and verify simplified analytical procedures to determine the environmental forces and force effects, element and system capacities, and reliabilities of TLPs, FPSO's, and Spars
Wave attenuation due to deformable seafloor conditions	Assignment Pending	Develop guidelines to characterize how interactions between surface waves and deformable sea floors result in changes in the wave amplitude and energy characteristics of the surface waves
Verification of shallow water wave kinematics and forces based on Cnoidal wave theory	Cory Clark	Verify shallow water wave kinematics based on Cnoidal wave theory with existing laboratory and field data. Verify shallow water wave forces on vertical cylinders based on Cnoidal wave theory kinematics and API wave force guidelines
Risk Assessment & Management based design and requalification criteria and guidelines for marine pipelines (with Dr. Xu, Prof. Bai, Dr. Mousselli, and Dr. Orisamolu	Assignment Pending	Develop reliability based design and requalification criteria for marine pipelines installation and operating condition s; working stress and load and resistance factor formats; loss of containment, buckling, stability and strength for hydrodynamic loadings and moving sea floor soil loadings

Current Publications

1997 - 1998

Fatigue of Ship Critical Structural Details, Journal of Offshore Mechanics and Arctic Engineering, Transactions of the American Society of Mechanical Engineers, Vol. 119, May, 96-107 (Dr. T. Xu, R. G. Bea).

Fatigue of Cracked Ship Critical Structural Details: Cracked S-N Curves and Load Shedding, International Journal of Offshore and Polar Engineering, Vol. 8, No. 2, June (Dr. T. Xu, R. G. Bea).

Towards Optimal Inspection Strategies for Fatigue and Corrosion Damage, 1997 Transactions of the Society of Naval Architects and Marine Engineers, Jersey City, New Jersey (Dr. K. T. Ma, Dr. I. R. Orisamolu, R. T. Huang, and R. G. Bea).

Siting and Evacuation Strategies for Mobile Drilling Units in Hurricanes, Journal of Marine Structures, Elsevier Science Ltdl., Kidlington, Oxford, UK (Dr. J. Ying, R. G. Bea).

Oceanographic and Reliability Characteristics of a Platform in the Mississippi River Delta, Journal of Geotechnical and Geoenvironmental Engineering, American Society of Civil Engineers, Herndon, Virginia (R. G. Bea)

A Reliability Based Screening Procedure for Platform Assessments and Requalifications, Journal of Offshore Mechanics and Arctic Engineering, Transactions of the American Society of Mechanical Engineers, Vol. 120, No. 3, (R. G. Bea, Dr. M. Mortazavi).

Hurricane Wave Conditions for Design and Requalification of Platforms in the Bay of Campeche, Mexico, Proceedings 1998 International OTRD Symposium Ocean Wave Kinematics, Dynamics and Loads on Structures, J. Zhang (Ed), American Society of Civil Engineers, Reston, Virginia (R. G. Bea, Dr. J. Suhayda, Z. Jin, and R. Ramos).

Hurricane Wave Forces on the Decks of Offshore Platforms, Proceedings 1998 International OTRD Symposium Ocean Wave Kinematics, Dynamics and Loads on Structures, J. Zhang (Ed), American Society of Civil Engineers, Reston, Virginia (R. G. Bea, J. Stear, T. Xu, and R. Ramos).

Simplified Strength-Level Earthquake Assessment of Jacket-Type Platforms, Proceedings 8th (1988) International Offshore and Polar Engineering Conference, Montreal, Canada, International Society of Offshore and Polar Engineering, Golden, Colorado (J. Stear, R. G. Bea).

Effects of Damage and Repairs on the Lateral Load Capacity of A Typical Template-Type Offshore Platform, Proceedings 8th (1988) International Offshore and Polar Engineering Conference, Montreal, Canada, International Society of Offshore and Polar Engineering, Golden, Colorado (T. Aviguetero, R. G. Bea).

Risk Based Hurricane and Earthquake Criteria for Design and Requalification of Platforms in the Bay of Campeche, Mexico, Proceedings Offshore Mechanics and Arctic Engineering Conference OMAE '98, Safety and Reliability Symposium, Lisbon, Portugal, American Society of Mechanical Engineers, New York, New York (R. G. Bea, R. Ramos, O. Valle, and V. Valdes).

Risk Assessment & Management Based Guidelines for Design & Reassessment of Pipelines in the Bay of Campeche, Mexico, Proceedings Offshore Mechanics and Arctic Engineering Conference OMAE '98, Safety and Reliability Symposium, Lisbon, Portugal, American Society of Mechanical Engineers, New York, New York (R. G. Bea, R. Ramos, T. Hernandez, and O. Valle).

Evaluation of the Reliability of Platform Pile Foundations in the Bay of Campeche, Mexico, Proceedings Offshore Mechanics and Arctic Engineering Conference OMAE '98, Safety and Reliability Symposium, Lisbon, Portugal, American Society of Mechanical Engineers, New York, New York (R. G. Bea, Z. Jin, C. Valle, and R. Ramos).

Risk Based Requalification of the Monopod Platform, Cook Inlet, Alaska, Proceedings Offshore Mechanics and Arctic Engineering Conference OMAE '98, Safety and Reliability Symposium, Lisbon, Portugal, American Society of Mechanical Engineers, New York, New York (R. G. Bea, Dr. J. Ying, D. Hopper, and M. Craig).

Safety Management Assessment System (SMAS) Part I: A Process for Identifying and Evaluating Human and Organization Factors in Operations of Offshore Platforms, Proceedings Offshore Mechanics and Arctic Engineering Conference OMAE '98, Safety and Reliability Symposium, Lisbon, Portugal, American Society of Mechanical Engineers, New York, New York (Dr. D. Hee, R. G. Bea, Dr. K. Roberts, and Dr. B. Williamson).

Safety Management Assessment System (SMAS) Part I: Field Test and Results, Proceedings Offshore Mechanics and Arctic Engineering Conference OMAE '98, Safety and Reliability Symposium, Lisbon, Portugal, American Society of Mechanical Engineers, New York, New York (Dr. D. Hee, R. G. Bea, Lt. Cmdr. Brant Pickrell, Dr. K. Roberts, and Dr. B. Williamson).

Non-Linear Dynamics of Caisson Well-Protectors During Hurricane Andrew, Report to U. S. Minearals Management Service, Herndon, Virginia, Marine Technology & Management Group, Dept. of Civil & Environmental Engineering, University of California, Berkeley, August (J. Wiseman, R. G. Bea).

Near Surface Wave Theory, Wave-in-Deck Forces, Report to Petroleos Mexicanos, Instituto Mexicano del Petroleo, and Brown and Root International, Marine Technology & Management Group, Dept. of Civil & Environmental Engineering, University of California, Berkeley, August (Dr. T. Xu, R. G. Bea).

Reassessment of Tubular Joint Capacity, Uncertainty and Reliability, Report to Petroleos Mexicanos, Instituto Mexicano del Petroleo, and Brown and Root International, Marine Technology & Management Group, Dept. of Civil & Environmental Engineering, University of California, Berkeley, August (Dr. T. Xu, R. G. Bea).

Analysis of Wave Attenuation in the Bay of Campeche, Report to Petroleos Mexicanos, Instituto Mexicano del Petroleo, and Brown and Root International, Marine Technology & Management Group, Dept. of Civil & Environmental Engineering, University of California, Berkeley, August (Z. Jin, R. G. Bea).

Dynamic Response of a Single Pile to Lateral Loading, Report to Petroleos Mexicanos, Instituto Mexicano del Petroleo, and Brown and Root International, Marine Technology & Management Group, Dept. of Civil & Environmental Engineering, University of California, Berkeley, August (Z. Jin, R. G. Bea).

Risk Based Hurricane and Earthquake Criteria for Design and Requalification of Platforms in the Bay of Campeche (Part I), Report to Petroleos Mexicanos, Instituto Mexicano del Petroleo, and Brown and Root International, Marine Technology & Management Group, Dept. of Civil & Environmental Engineering, University of California, Berkeley, September (R. G. Bea).

Risk Based Criteria for Design and Requalification of Pipelines and Risers in the Bay of Campeche (Part I), Report to Petroleos Mexicanos, Instituto Mexicano del Petroleo, and Brown and Root International, Marine Technology & Management Group, Dept. of Civil & Environmental Engineering, University of California, Berkeley, September (R. G. Bea).

Report #1 - Reliability Characteristics of the Pol A Compression Platform, Platform Structure & Foundation Performance Analyses, Report to Petroleos Mexicanos, Instituto Mexicano del Petroleo, and Brown and Root International, Marine Technology & Management Group, Dept. of Civil & Environmental Engineering, University of California, Berkeley, October (R. G. Bea).

Report #2 - Reliability Characteristics of the Pol A Compression Platform, Platform Reassessment and Requalification Evaluations, Report to Petroleos Mexicanos, Instituto Mexicano del Petroleo, and Brown and Root International, Marine Technology & Management Group, Dept. of Civil & Environmental Engineering, University of California, Berkeley, September (R. G. Bea).

Safety Management Assessment Systemn (SMAS), Marine Technology & Management Group, Dept. of Civil and Environmental Engineering, University of California, Berkeley, November (with Dr. D. Hee)

Risk Based Hurricane Criteria for Design of Floating and Subsea Systems in the Bay of Campeche, Report to Petroleos Mexicanos, Instituto Mexicano del Petroleo, and Brown & Root International Inc., Marine Technology & Management Group, University of California, Berkeley, December (R. G. Bea).

Analysis of Hurricane Wave Decay Characteristics, Risk Based Criteria for Design & Requalification of Offshroe Platforms in the North Region, Report to Petroleos Mexicanos, and Instituto Mexicano del Petroleo, Marine Technology & Management Group, University of California, Berkeley, December (Z. Jin, R. G. Bea).

Risk Based Life Cycle Fatigue Criteria, Report to Petroleos Mexicanos, Instituto Mexicano del Petroleo, and Brown & Root International Inc., Marine Technology & Management Group, University of California, Berkeley, December (Dr. T. Xu, R. G. Bea).

Dynamic Lateral and Axial Loading Capacities of Piles in the Bay of Campeche, Report to Petroleos Mexicanos, Instituto Mexicano del Petroleo, and Brown & Root International Inc., Marine Technology & Management Group, University of California, Berkeley, December (Z. Jin, R. G. Bea)

Risk Based Hurricane Criteria for Design of Floating and Subsea Systems in the Bay of Campeche, Report to Petroleos Mexicanos, Instituto Mexicano del Petroleo, and Brown & Root International Inc., Marine Technology & Management Group, University of California, Berkeley, December (R. G. Bea).

Report #1A, Reliability Characteristics of the Pol A Compression Platform, Platform Ultimate Limit State Limit Equilibrium (ULSLEA) and Reliability Analyses, Report to Petroleos Mexicanos, Instituto Mexicano del Petroleo, and Brown & Root International, Inc., Marine Technology and Management Group, Dept. of Civil & Environmental Engineering, University of California at Berkeley, December (Dr. T.Xu, R. G. Bea)

Workshops on 1997 Projects - risk Based Hurricane and Earthquake Criteria for Design and Requalifiation of Platforms, Pipelines, Risers, and Floating Systems in the Bay of Campeche, Report to Petroleos Mexicanos, Instituto Mexicano del Petroleo, and Brown & Root International, Inc., Marine Technology & Management Group, Dept. of Civil & Environmental Engineering, University of California, Berkeley, December (Dr. T. Xum Z. Jin, R. G. Bea).

Risk Based Hurricane and Earthquake Criteria for Design and Requalification of Platforms in the North Region (Tampico and Tuxpan), Final Report to Petroleos Mexicanos and Instituto Mexicano del Petroleo, Marine Technology & Management Group, Dept. of Civil & Environmental Engineering, University of California, Berkeley, December (R. G. Bea).

Risk Based Stability Criteria for Dsign of the Second Trunkline on the North West Shelf of Western Australia, Report to BRK Joint Venture and Woodside Offshore Petroleum Pty. Ltd., Perth, Western Australia, Marine Technology & Management Group, Dept. of Civil & Environmental Engineering, University of California, Berkeley, December (R. G. Bea).

Risk Based Oceanographic & Earthquake Load and Resistance Factor Criteria for Design and Requalification of Platforms Offshore Indonesia, Report to Indonesian Petroleum Association, Directorate General of Oil & Gas of Indonesia, and Bandung Institute of Technology, Marine Technology & Management Group, Dept. of Civil & Environmental Engineering, University of California, Berkeley, December (R. G. Bea).

Comparative Evaluation of Minimum Structures and Jackets, Stage II: Analysis of Human and Organizational Factors, Report to Joint Industry - Government Sponsored Project, Marine Technology & Management Group, Dept. of Civil & Environmental Engineering, University of California, Berkeley, December (R. G. Bea, Lt. R. Lawson).

SYRAS, System Risk Assessment Software, Version 1.0, , Report to Joint Industry - Government Sponsored Project, Marine Technology & Management Group, Dept. of Civil & Environmental Engineering, University of California, Berkeley, December (Lt. R. Lawson, R. G. Bea).

Reassessment of Tubular Joint Capacity, Screening Methodolgies Project Phase IV, 38) Comparative Evaluation of Minimum Structures and Jackets, Stage II: Analysis of Human and Organizational Factors, Report to Joint Industry - Government Sponsored Project, Marine Technology & Management Group, Dept. of Civil & Environmental Engineering, University of California, Berkeley, January (Dr. T. Xu, R. G. Bea).

Loading and Capacity Characteristics of Pile Foundations: Correlation of Calculation Results with ULSLEA, Screening Methodlogies Project Phase IV, Report to Joint Industry - Government Sponsored Project, Marine Technology & Management Group, Dept. of Civil & Environmental Engineering, University of California, Berkeley, January (Z. Jin, R. G. Bea).

Continued Development of Earthquake Load and Resistance Factor Design Guidelines, Report 1, Concrete Gravity Based Structures LRFD Guidelines, Report to Health and Safety Executive, Offshore Safety Division, Bootle, Merseyside, UK, Marine Technology & Management Group, Dept. of Civil & Environmental Engineering, University of California, Berkeley, March (R. G. Bea).

Report #1B, Reliability Characteristics of the Pol A Compression Platform, Updated Platform Ultimate Limit State Limit Equilibrium (ULSLEA) and Reliability Analyses, Report to Petroleos Mexicanos, Instituto Mexicano del Petroleo, and Brown & Root International Inc., Marine Technology & Management Group, Dept. of Civil & Environmental Engineering, University of California, Berkeley, April (Dr. T. Xu, R. G. Bea).

Continued Development of Earthquake Load and Resistance Factor Design Guidelines, Report 2, Seismic Hazard Characterizations, Report to STATOIL and UNOCAL, Stavanger, Norway, Houston, Texas, Marine Technology & Management Group, Dept. of Civil & Environmental Engineering, University of California, Berkeley, May.

Development of a Safety Management Assessment System for the International Safety Management Code, Report to the U. S. Coast Guard, Washington, DC, Marine Technology & Management Group, Dept. of Civil & Environmental Engineering, University of California, Berkeley, May (Lt. P. Szwed, R. G. Bea).

Rigs-to-Reefs Siting and Design Study for Offshore California: Addressing the Issues Developed During Workshop "Recent Experiences and Future Deepwater Challenges," Report to California Sea Grant College Program and the U. S. Minerals Management Service, La Jolla, California, Herndon, Virginia, Marine Technology & Management Group, Dept. of Civil & Environmental Engineering, University of California, Berkeley, May (J. Wiseman, R. G. Bea).

Risk Based Oceanographic Criteria for Platforms in the Bay of Campeche, Proceedings of the Symposium on Risk Based Criteria, Petroleos Mexicano (PEMEX0 and Instituto Mexicano del Petroleo (IMP), Mexico City, September (R. G. Bea).

Risk Based Criteria for the Design, Construction, and Operation of Deep Water Structures, Proceedings of the 3rd International Symposium on Offshore Hydrocarbon Exploration Technologies, Instituto Mexicano del Petroleo, Mexico, City, October (R. G. Bea).

Analysis of Siting and Evacuation Strategies for Mobile Drilling Units in Hurrianes, Proceedings of the Offshore Technology Conference, OTC 8707, Society of Petroleum Engineers, Richardson, Texas (Dr. J. Ying, R. G. Bea).

Risk Assessment & Management Based Hurricane Wave Criteria for Design and Requalification of Platforms in the Bay of Campeche, Proceedings of the Offshore Technology Conference, OTC 8692, Society of Petroleum Engineers, Richardson, Texas (R. G. Bea, R. Ramos, O. Valle, V. Valdes, andR. Maya).

Risk Assessment & Management Based Hurricane Wave Criteria for Design and Requalification of Pippelines and Risers in the Bay of Campeche, Proceedings of the Offshore Technology Conference, OTC 8695, Society of Petroleum Engineers, Richardson, Texas (R. G. Bea, R. Ramos, O. Valle, V. Valdes, andR. Maya).

Development and Application of Risk Evaluation Methods for a Bay of Campeche Offshore Platform, Proceedings of the Offshore Technology Conference, OTC 8696, Society of Petroleum Engineers, Richardson, Texas (M. Chavez, D. Hopper, R. Roberts, V. Valdes, O. Valle, R. G. Bea).

Key Issues Associated with Development of Reassessment & Requalifiation Criteria for Platforms int he Bay of Campeche, Mexico, Proceedings of the International Workshop on Platform Requalification, 17th International Conference on Offshore Mechanics and Arctic Engineering OMAE '98, Lisbon, Portugal, American Society of Mechanical Engineers, New Yortk, New York (R. G. Bea, O. Valle).

Quality Assurance for Marine Structures, Proceedings of the 13th International Ship and Offshore Structures Congress, Trondheim, Norway (R. G. Bea, Dr. S-C Leee, Prof. A. Ulvarson, Prof. O. Westby, Dr. W. H. Moore, Captain D. L. Stanley, Dr. B. L. Thompson, and Dr. T. Xu)

1996 - 1997

Human and Organization Errors in Reliability of Offshore Structures, Transactions of the American Society of Mechanical Engineers, Vol. 119, Feb. 1997 (R. G. Bea).

Evaluation of Storm Loadings on and Capacities of Offshore Platforms, Journal of waterway. Port, Coastal, and Ocean Engineering, American Society of Civil Engineers, Vol. 123, No. 2, March/April 1997 (R. G. Bea, M. M. Mortazavi, and K. J. Lock).

Capacities of Template-Type Platforms in the Gulf of Mexico During Hurricane Andrew, Journal of Offshore Mechanics and Arctic Engineering, American Society of Mechanical Engineers, Vol. 119, Feb. 1997 (R. G. Bea, K. J. Lock and P. L. Young).

ULSLEA: A Limit Equilibrium Procedure to Determine the Ultimate Limit State Loading Capacities of Template Type Platforms, Journal of Offshore Mechanics and Arctic Engineering, American Society of Mechanical Engineers, Vol. 118, Nov. 1996 (R. G. Bea, M. M. Mortazavi).

Load Shedding of Fatigue Fracture in Ship Structures, Journal of Marine Structures, Vol 10, Elsevier, 1997 (R. G. Bea, T. Xu).

Assessing the Risks and Conutermeasures for Human and Organizational Error, Transactions, American Society of Naval Architects and Marine Engineers, 1996 (R. G. Bea, Lt. D. Boniface).

Human and Organization Factors: Engineering Operating Safety Into Offshore Structures, Reliability Engineering and System Safety, Vol 52, Elsevier Science Limited, 1997.

Fatigue of Ship Critical Structural Details, Journal of Offshore Mechanics and Arctic Engineering, American Society of Mechanical Engineers, May 1997 (R. G. Bea, T. Xu).

In-Service Inspection Programs for Marine Structures, Proceedings 16th International Conference on Offshore Mechanics and Arctic Engineering, American Society of Mechanical Engineers, Yokohama, Japan, 1997 (R. G. Bea, T. Xu).

Managing Rapidly Developing Crises: Real-Time Prevention of Marine System Accidents, Proceedings 16th International Conference on Offshore Mechanics and Arctic Engineering, American Society of Mechanical Engineers, Yokohama, Japan, 1997 (R. G. Bea, K. Roberts).

Reliability Based Load and Resistance Factor Design Guidelines for Offshore Platforms to Resist Earthquakes, Proceedings 16th International Conference on Offshore Mechanics and Arctic Engineering, American Society of Mechanical Engineers, Yokohama, Japan, 1997 (R. G. Bea, M. J. K. Craig).

Comparative Analysis of the Capacities of Gulf of Mexico Steel Template-Type Platforms Subjected to Hurricane Forces, Proceedings 16th International Conference on Offshore Mechanics and Arctic Engineering, American Society of Mechanical Engineers, Yokohama, Japan, 1997 (R. G. Bea, J. Stear).

Background for the Proposed International Standards Organization Reliability Based Seismic Design Guidelines for Offshore Platforms, Earthquake Criteria Workshop Proceedings, 16th International Conference on Offshore Mechanics and Arctic Engineering, American Society of Mechanical Engineers, Yokohama, Japan, 1997.

Reassessment and Requalification of Two Gulf of Mexico Platforms, Proceedings 7th International Conference on Offshore and Polar Engineering, Honolulu, Hawaii, May 1997 (R. G. Bea, A. Sturm and T. Miller).

Reliability Based Design & Requalification Criteria for Longitudinally Corroded Pipelines, Proceedings 7th International Conference on Offshore and Polar Engineering, Honolulu, Hawaii, May 1997 (Y. Bai, T. Xu, and R. G. Bea).

Offshore Single Point Mooring Systems for Import of Hazardous Liquid Cargoes Offshore Southern California, Proceedings 7th International Conference on Offshore and Polar Engineering, Honolulu, Hawaii, May 1997 (R. G. Bea, A. Salancy)

Experimental Validation of the Ultimate Limit State Limit Equilibrium Analysis (ULSLEA) with Results from Frame Tests, Proceedings 7th International Conference on Offshore and Polar Engineering, Honolulu, Hawaii, May 1997 (R. G. Bea, M. Mortazavi).

Experience with Fast Rack Risk Assessment Used to Compare Alternative Platforms, Proceedings of the International Conference on Safety and Reliability, European Safety and Reliability Association, Lisbon, Portugal, June 1997 (R. G. Bea, A. Brandtzaeg).

Human and Organizational Factor Considerations in the Structure Design Process for Offshore Platforms, Proceedings of the International Workshop on Human Factors in Offshore Operations, U. S. Minerals Management Service, New Orleans, Louisiana, Dec. 1996 (R. G. Bea).

Accident and Near-Miss Assessments and Reporting, Human and Organizational Factor Considerations in the Structure Design Process for Offshore Platforms, Proceedings of the International Workshop on Human Factors in Offshore Operations, U. S. Minerals Management Service, New Orleans, Louisiana, Dec. 1996 (R. G. Bea).

Real-Time Prevention of Platform Drilling Blowouts: Managing Rapidly Developing Crises, Human and Organizational Factor Considerations in the Structure Design Process for Offshore Platforms, Proceedings of the International Workshop on Human Factors in Offshore Operations, U. S. Minerals Management Service, New Orleans, Louisiana, Dec. 1996 (R. G. Bea).

A Safety Management Assessment System (SMAS) for Offshore Platforms, Human and Organizational Factor Considerations in the Structure Design Process for Offshore Platforms, Proceedings of the International Workshop

on Human Factors in Offshore Operations, U. S. Minerals Management Service, New Orleans, Louisiana, Dec. 1996 (R. G. Bea).

Human and Organization Factors in Safety of Offshore Platforms, Proceedings of the International Workshop on Human Factors in Offshore Operations, U. S. Minerals Management Service, New Orleans, Louisiana, Dec. 1996 (R. G. Bea).

A Decision Analysis Framework for Assessing Human and Organizational Error in the Marine Industries, Proceedings of the Symposium on Human and Organizational Error in Marine Structures, Ship Structure Committee - Society of Naval Architects and Marine Engineers, Arlington, Virginia, November 1996 (R. G. Bea, Lt. D. Boniface).

Consideration of Human and Organization Factors in Development of Design, Construction, and Maintenance Guidelines for Ship Structures, Proceedings of the Symposium on Human and Organizational Error in Marine Structures, Ship Structure Committee - Society of Naval Architects and Marine Engineers, Arlington, Virginia, November 1996 (R. G. Bea).

High Reliability Tanker Loading & Discharge Operations: Chevron Long Wharf, Richmond, California, Proceedings of the Symposium on Human and Organizational Error in Marine Structures, Ship Structure Committee - Society of Naval Architects and Marine Engineers, Arlington, Virginia, November 1996.

Ship Structural Integrity Information System Phase II, Ship Structure Committee SSC 388, Washington, DC, 1996, NTIS #PB96-167564 (R. G. Bea, M. Dry, R. Schulte-Strathaus).

Risk Based Oceanographic Criteria for Design and Requalification of Platforms in the Bay of Campeche, Report to Petroleos Mexicanos and Instituto Mexicano del Petroleo, March 1997 (R. G. Bea).

Structural Reliability of the Monopod Platform, Report to Unocal Corporation, December 1997 (R. G. Bea, J. Ying).

ULSLEA: Parametric Studies of the Effects of Local Damage and Repairs on Global Lateral Load Capacity of a Typical Offshore Platform, Report to U. S. Minerals Management Service and Joint Industry Project Sponsors, Dec. 1996 (R. G. Bea, T. Aviguerto).

Marine Infrastructure Rejuvenation Engineering: Fatigue and Fracture of Critical Structural Details (CSD), Marine Technology and Management Group Report, University of California at Berkeley, Jan. 1997 (R. G. Bea, T. Xu).

Ship Maintenance Project: Program Summary and Rational Basis for Corrosion Limits on Tankers, Ship Structure Committee SSC 395, Washington, DC, NTIS #PB97-142822.

Ship Maintenance Project: Study of Fatigue of Proposed Critical Structural Details in Double Hull Tankers, Ship Structure Committee SSC 395, Washington, DC, NTIS #PB97-142830.

Ship Maintenance Project: Repair Management System for Critical Structural Details in Ships, Ship Structure Committee SSC 395, Washington, DC, NTIS #PB97-142848.

Ship Maintenance Project: Fatigue Classification of Critical Structural Details in Tankers, Ship Structure Committee SSC 395, Washington, DC, NTIS #PB97-142855.

Ship Maintenance Project, Fitness for Purpose Evaluation of Critical Structural Details in Tankers, Ship Structure Committee SSC 395, Washington, DC, NTIS #PB97-142863.

Assessment of Human and Organizational Factors in Operations of Marine Terminals and Offshore Platforms, Marine Technology Management Group Report, University of California at Berkeley, May 1997 (R. G. Bea, Lt. B. Pickrell).

Ship Structural Integrity Information System: Phase III - SSIIS IIIl, Marine Technology and Managment Group Report, University of California at Berkeely, May 1997 (R. G. Bea, H. P. Reeve).

Life Cycle Reliability & Risk Characteristics of Minimum Structures, Proceedings of the Offshore Technology Conference, Houston, Texas, OTC 8361, May 1997 (R. G. Bea, M. Craig and T. Miller).

Ultimate Limit State Capacity Analyses of Two Gulf of Mexico Platforms, Proceedings of the Offshore Technology Conference, Houston, Texas, OTC 8418, May 1997 (R. G. Bea, J. Stear).

Conceptual Approaches to the Risk Mitigation Challenge: An Engineer's Perspectives, Proceedings of the First Annual Conference of the Center for Risk Mitigation, University of California at Berkeley, June 1997 (R. G. Bea).

A Safety Management Assessment System: SMAS, Proceedings of the First Annual conference of the Center for Risk Mitigation, University of California at Berkeley, June 1997 (R. G. Bea, D. Hee).

Crisis Management and the Near Miss, Surveyor, American Bureau of Shipping, Sept. 1996.

Evaluation of the West Cameron 5452 #6 and #7 Well Caisson Capacity Characteristics, Report to Chevron (Operator), & Partners (Unocal, CNG Production Co., & Phillips), Ocean Engineering Services, Department of Civil and & Environmental Engineering, University of California at Berkeley, May 1997 (R. G. Bea).

PIMPIS: Knowledge-Based Pipeline Inspection, Maintenance & Performance Information System, Progress Report #1, Dept. of Civil & Environmental Engineering, Marine Technology & Management Group, University of California, Berkeley, June 1997 (R. G. Bea, T. Elsayed).

SCREENING METHODOLOGIES FOR USE IN OFFSHORE PLATFORM ASSESSMENT AND REQUALIFICATION

Project Objective:

Further develop and verify simplified quantitative screening methodologies for Level 2 platform assessments so these methodologies may be used in practice

Phase I: June 1993 to May 1995

Phase II: June 1995 to May 1996

Phase III: June 1996 to May 1997

Phase IV: June 1997 to June 1998

Phase IV EXTENSION:
July 1998 to December 1998

PHASE IV PROJECT SPONSORS

ARCO Exploration and Production Technology

Exxon Production Research Company

Mobil Technology Company

Shell Deepwater Development Company

Unocal Corporation

US Minerals Management Service

PEMEX/IMP

Chevron Petroleum Technology Company

PHASE IV DELIVERABLES

#1:

Documentation of TOPCAT program enhancements, comparisons, developments, evaluations, and verifications

#2:

Updating of TOPCAT user and modeling guide; updating of TOPCAT software

#3:

Three meetings

ULSLEA PHASE I

- Aero and hydrodynamic loadings ✓
- Unbraced deck legs capacity ✓
- Jacket capacity (legs, braces, joints) ✓
- Foundation capacity ✓
- Deterministic ULS analysis ✓
- Probabilistic ULS analysis ✓
- Damaged and grout-repaired members ✓
- Verification case studies (5) ✓
- ULSLEA program documentation ✓
- Meetings (2) ✓

ULSLEA PHASE II

- Modeling enhancements ✓
- Code updating and enhancement ✓
- Preliminary design of braces ✓
- Jacket horizontal framing effects ✓
- Additional verifications (2) ✓
- Linear analysis comparisons ✓
- User - modeling guide ✓
- Reporting and documentation ✓
- Meetings (2) ✓

ULSLEA PHASE III

- Fatigue analysis algorithms ✓
- Earthquake analysis algorithms ✓
- Verifications of earthquake analysis (3) ✓
- Earthquake deck spectra ✓
- Additional configurations ✓
- Platform strength and robustness studies ✓
- Code updating ✓
- Reporting and documentation ✓
- Meetings (2) ✓

TOPCAT PHASE IV

- Platform Damage Studies (1 of 3) ✓
- Ductility-Level Earthquake Analysis ✓
- Diagonal Loads on Platforms
- Additional Configurations (2) ✓
- Tubular Joint Uncertainties ✓
- Platform Foundations ✓
- Improved Input / Output ✓
- Lifetime Reliability (Storms and Quakes)
- Wave Spatial Effects ✓
- Shallow Water Kinematics ✓
- Deck Elements
- Reporting and documentation ✓
- Meetings (2) ✓

TOPCAT PHASE IV Extension

- Ductility-Level Earthquake Analysis ✓
- Modification of Existing Modules ✓
- Improved Interface ✓
- Wave Spatial Effects Modification ✓
- Diagonal Loads on Platforms ✓
- Long-term Reliability Analysis (Storms) ✓
- Deck Elements Analysis ✓
- Wave Forces on Decks Verification ✓
- Shallow Water Kinematics Verification ✓
- Global Torsion Analysis
- Optimal Platform Configurations
- Reporting and Documentation
- Meetings (1)

FROM 2-D Model To 3-D Model: New Version TOPCAT

With spatial effects and diagonal loads counted in, with the incoming torsion research task, a 3-D TOPCAT model is in need.

Topics of Future Research / Enhancement:

1. Update TOPCAT to Excel 97 Environments
2. Revision of Data Structure in TOPCAT Excel Sheets, and Data Communication between Modules
3. Transfer Complicated Subroutines into Standardized Independent Procedures
4. Case Studies and Verifications
5. Develop 3-D Representation of Platforms
6. Distributed Loads and Global Torsion
7. Optimal Platform Configurations

PHASE V:
PLAN FOR NEXT 11 MONTHS

Task /GSR	1999 1 6	1999 7 12
Update to Excel 97 *Jin*	--X	
TOPCAT Data Structure *Jin*	-------X	
3-D Representation *Jin*	---------x	
Global Torsion *Jin*	----------------x	
Optimal Platforms *Jin*		---------------x
Verification and Debugging *Jin*	----------------x	---------------x
Updated Software *Jin*	x	x
Meetings	x	x

EQ/DUCTILITY STUDIES

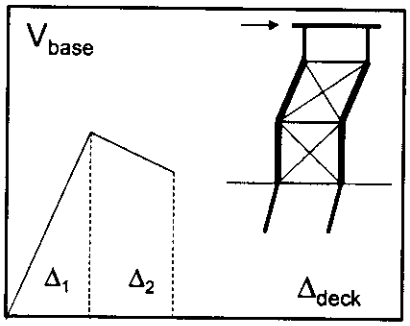
TOPCAT
Template Offshore Platform Capacity Assessment Tools

- Simple Ductility Analysis
- EQ Response Factors
- EQ Case Studies
- Minor Enhancements
- Bug Fixes

by James D. Stear

Simple Ductility Analysis

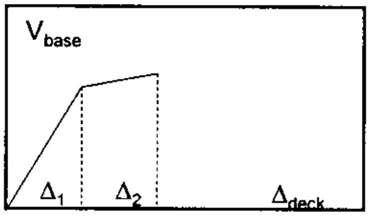
Goal: Approximate Global μ



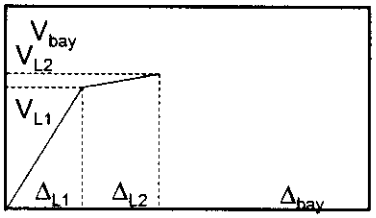
Global Load-Displacement

Assumptions:
- Damage concentrates in mechanisms
- Limits established from structure, residual strength, drift

Deck Mechanism

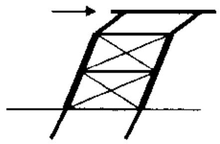


Global Load-Displacement



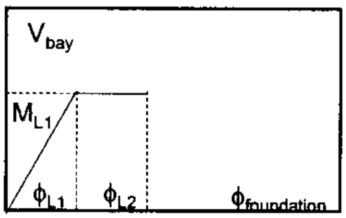
Deck Bay Load-Displacement

- **Local limit set by leg hinge ductility (2 or less)**
- **Other components displace in proportion to load increase**

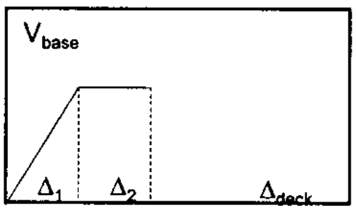


$\Delta_{max} = \Delta_1 + \Delta_2 = \Delta_1(V_{L2}/V_{L1}) + \Delta_{L2} - \Delta_{L1}(V_{L2}/V_{L1})$

Foundation Mechanisms

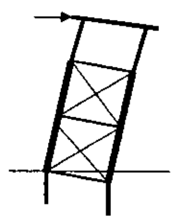


Found. ϕ Load-Displacement



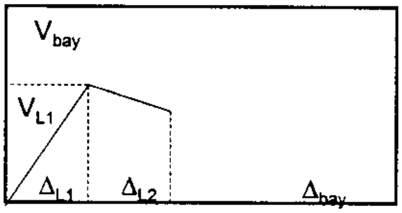
Global Load-Displacement

- **Lateral: limit on hinge ductility (2 or less)**
- **Overturning: limit on local ductility (2) or global ductility**

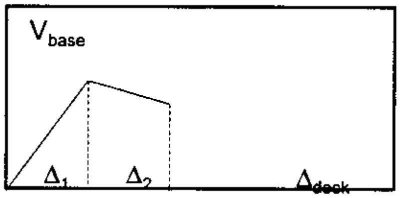


$\Delta_{max} = \Delta_1 + \Delta_2 = \Delta_1 + H\phi_{L2}$

Jacket Mechanisms



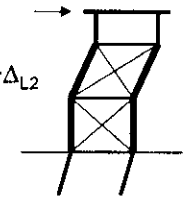
Jacket Bay Load-Displacement



Global Load-Displacement

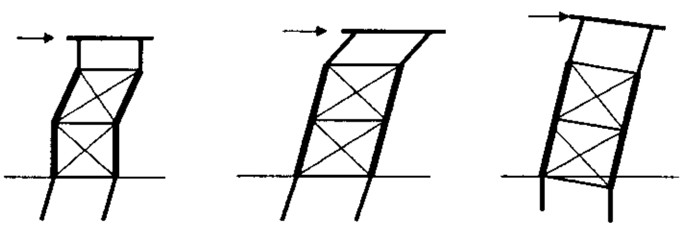
- Weak/strong mechanisms
- Approximate effects of minimum horizontals, K-braces
- Limit based on residual strength, bay drift

$\Delta_{max} = \Delta_1 + \Delta_2 = \Delta_1 + \Delta_{L2}$



Global Safety Limits

- 70% residual strength requirement
- Global $\mu = 3$
- Drift in a foundation overturning mechanism = 1%



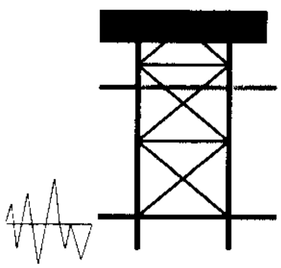
Limitations

TOPCAT

Template Offshore Platform Capacity Assessment Tools

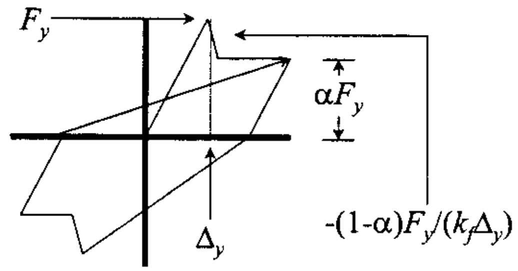
- Approach is very approximate, based on damage trends identified in static pushover analyses
- No rigorous tracking of member stresses, strains, load redistribution
- No torsion effects, behavior restricted to EO/BS only
- Procedure needs additional calibration

EQ Response Factors



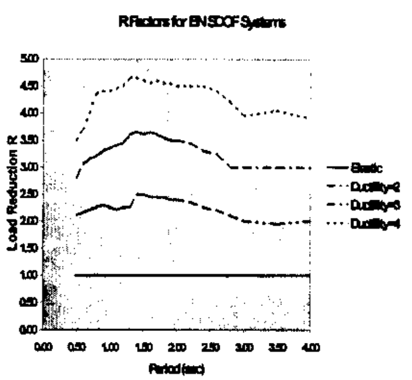
- Have developed load reduction/displacement factors for jacket-type, foundation-type mechanisms
- Have studied MDOF systems to compare with SDOF approximation

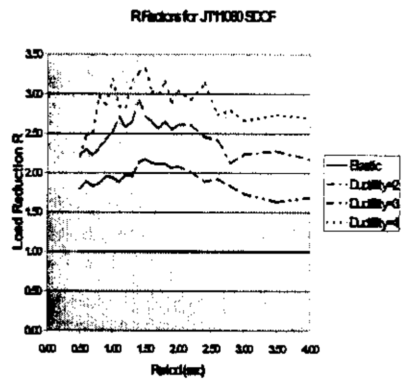
Jacket-Type SDOF



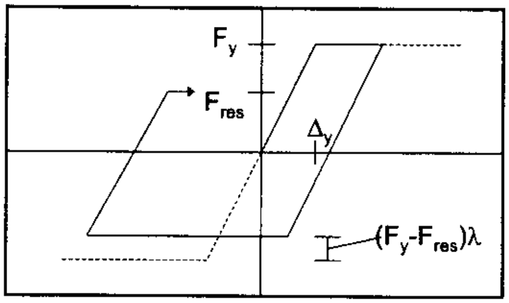
- Stiffness degrading (Clough)
- 80% and 60% residual (α)
- Five negative stiffness factors (k_f): 0.01, 1, 2, 3, 4
- Periods from 0.5 sec to 4.0 sec

Jacket-Type, Bilinear (+3%)



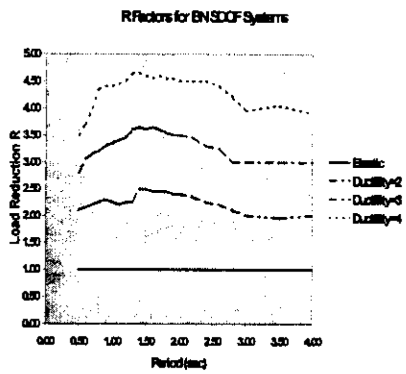


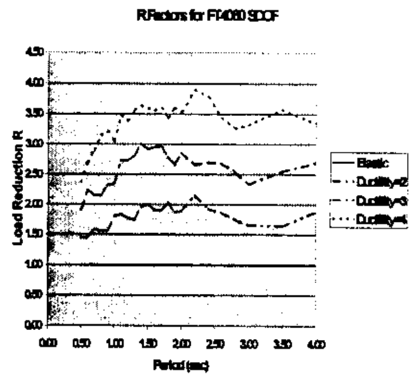
Foundation-Type SDOF



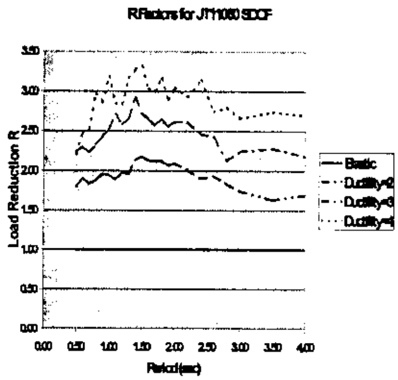
- Strength-degrading only (Matlock)
- 80% and 60% residual
- Two degradation rates: 0.2, 0.4
- Periods from 0.5 sec to 4.0 sec

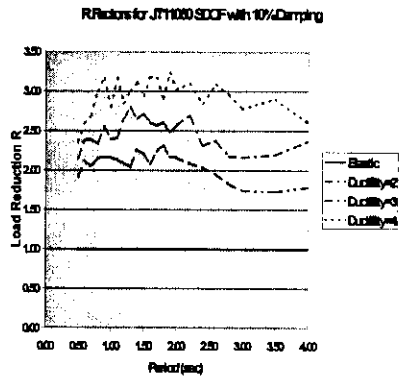
Foundation-Type, BL (+3%)



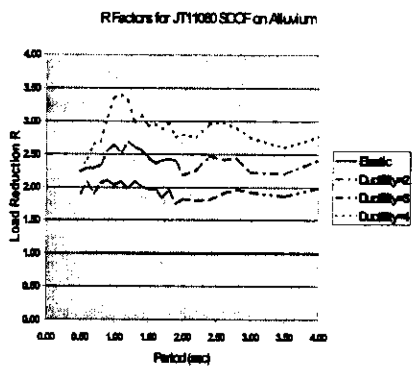


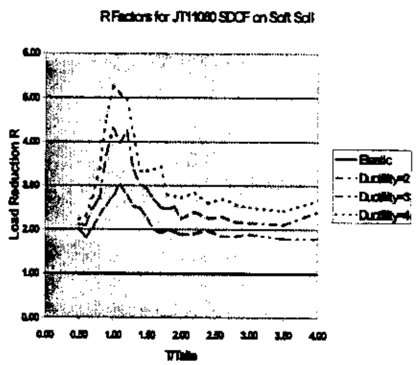
Damping 5% and 10%





Medium Stiff, Soft Soils





Correction Factor

$$F_e = \alpha\mu$$

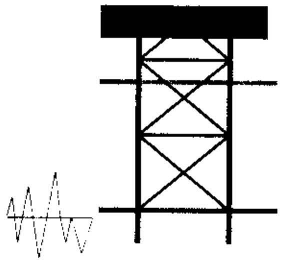
- Works well for JT, very conservative for FT
- Generally conservative over range from T = 1.0 sec to 4.0 sec for JT systems
- Can overpredict load reduction by 20% in range from T = 0.5 sec to 1.0 sec
- Needs to be adjusted for soft soil site conditions

SDOF/MDOF Comparisons

$$F_\mu \ vs. R$$

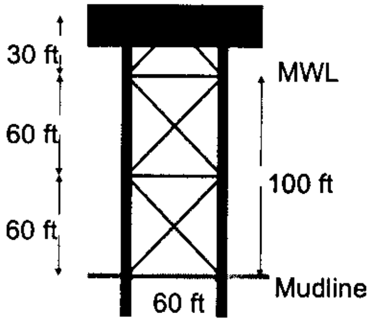
- MDOF JT, FT systems analyzed, with 1st mode mass participation from 90% to 60%
- For 60% to 70%, effective yield strength is lower that predicted from pushover analysis
- For 60% to 70%, F_μ is higher, with more scatter
- Good between R and F_μ agreement in range 80% to 90%

EQ Case Studies



GOALS:
- Evaluate simple ductility
- Assess use of factor-modified static analysis for judging earthquake performance

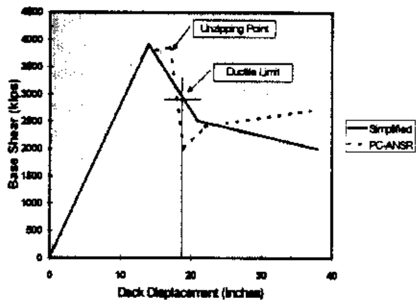
Case Study 1



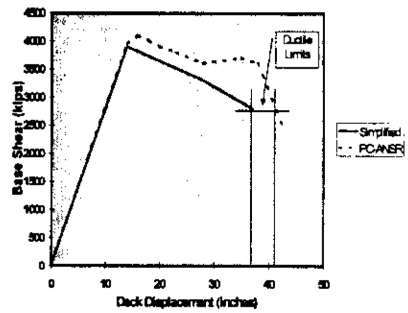
- 4 piles
- T1 = 1.5 sec
- Founded on firm soils
- Strong and weak horizontal bracing

Case Study 1

Weak Horizontals



Strong Horizontals



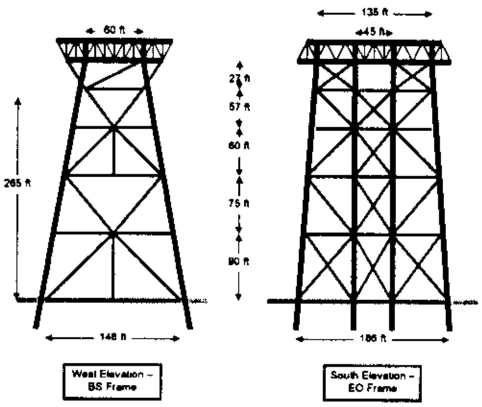
Case Study 1

$$F_\mu \; vs. R$$

A MDOF	$S_{a\text{-}yield}$ (g)	COV	F_μ Global	F_μ Global COV
Weak	0.47	0.05	1.44	0.21
Strong	0.47	0.05	3.06	0.24

A SDOF	$S_{a\text{-}yield}$ (g)	R Global
Weak	0.47	1.3
Strong	0.47	2.7-2.9

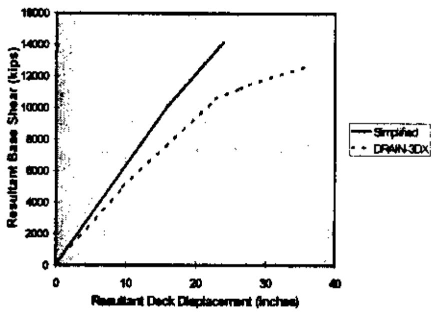
Case Study 2



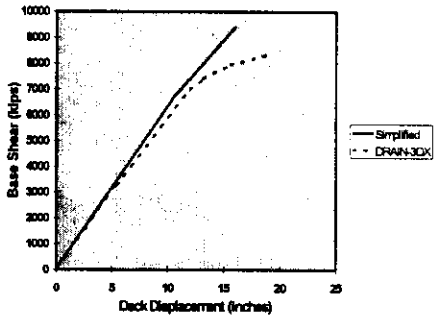
- 8 piles
- T1 = 2.84 sec
- Founded on medium soils
- Supports 80 conductors

Case Study 2

End-On



Broadside

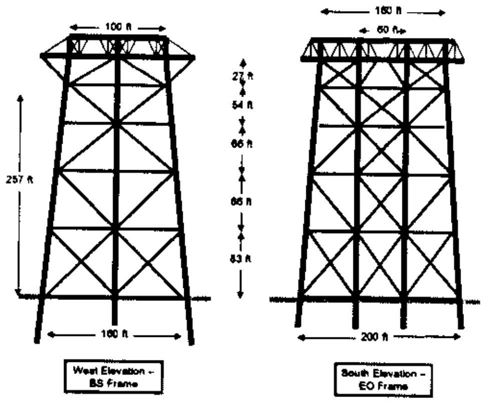


Case Study 2

B	$S_{a\text{-}yield}$ (g)	COV	F_μ Global	F_μ Global COV
MDOF	0.33	0.10	1.68	0.19

B	$S_{a\text{-}yield}$ (g)	R Global
SDOF	0.29	1.5

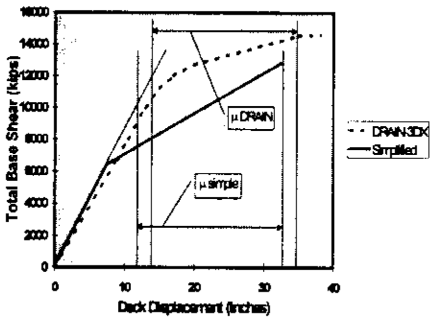
Case Study 3

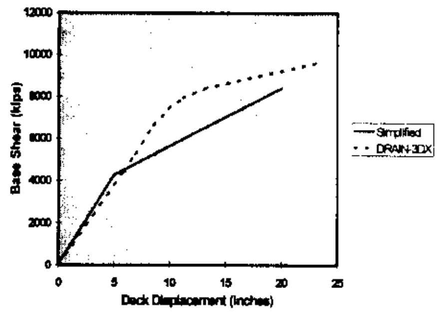


- 12 piles
- T1 = 2.36 sec
- Founded on medium soils

Case Study 3

End-On | **Broadside**



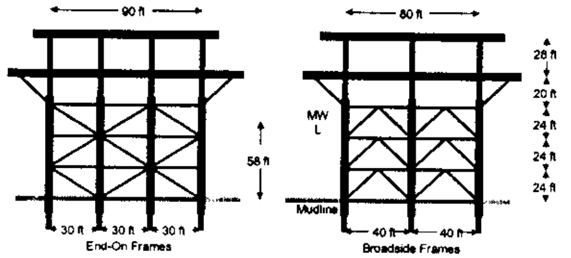


Case Study 3

B	$S_{a\text{-}yield}$ (g)	COV	F_μ Global	F_μ Global COV
MDOF	0.30	0.11	3.10	0.29

B	$S_{a\text{-}yield}$ (g)	R Global
SDOF	0.25	2.7-3.0

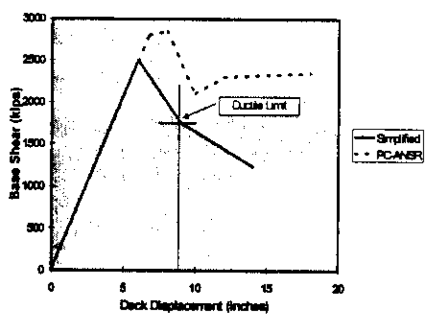
Case Study 4



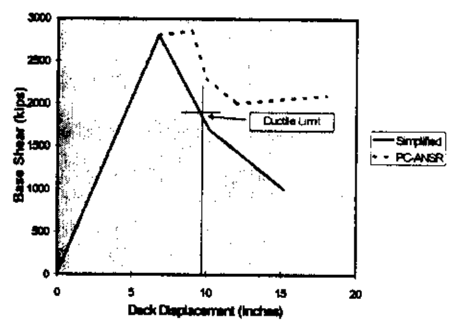
- 12 piles
- T1 = 1.0 sec
- Founded on medium soils

Case Study 4

End-On



Broadside



Case Study 4

B	$S_{a\text{-}yield}$ (g)	COV	F_μ Global	F_μ Global COV
MDOF	0.42	0.12	2.02	0.18

B	$S_{a\text{-}yield}$ (g)	R Global
SDOF	0.3-0.46	1.6-2.0

Case Studies: Summary

- **Static approximation compares well with dynamic analysis when higher mode effects are small.**
- **Simple ductility approach provides reasonable ductility estimate; hysteresis curve is very approximate. Absence of solid link to local ductility makes calibration to local events difficult.**

Minor Enhancements

- ISO EQ Spectra
- Ductility-modified EQ response
- Lower-bounds for legs, piles
- Ultimate strength "search" in jacket bays

TOPCAT
Template Offshore Platform Capacity Assessment Tools

Bug Fixes

- Joint input
- Jacket leg input
- Jacket bending stiffness
- Soil updating of input files
- Soil output table

TOPCAT
Template Offshore Platform Capacity Assessment Tools

TOPCAT UPDATING AND ENHANCEMENTS, Fall '98

Report to Joint Industry Project ponsors

TOPCAT
Template Offshore Platform Capacity Assessment Tools

by
Zhaohui Jin
and Professor R.G. Bea
Departmentt of Civil and
Environmental Engineering
University of California at Berkeley

1. Revision and Modification

- Interface
- Reliability and Sensitivity Modules
- Cnoidal Wave Kinematics Module
- Spatial Effects Module

2. Diagonal Load Analysis

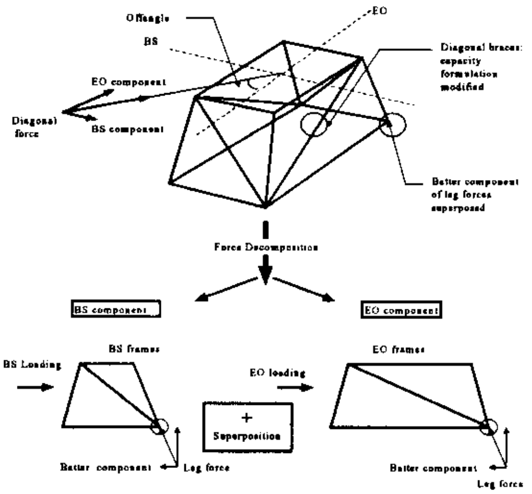
Assumption:

- Global diagonal load acting at the centeroid
- Torque from spatial effect neglected

Two main steps:

- Decomposition and superposition at global level
- Detailed analysis at local level

Global Superposition and Decomposition



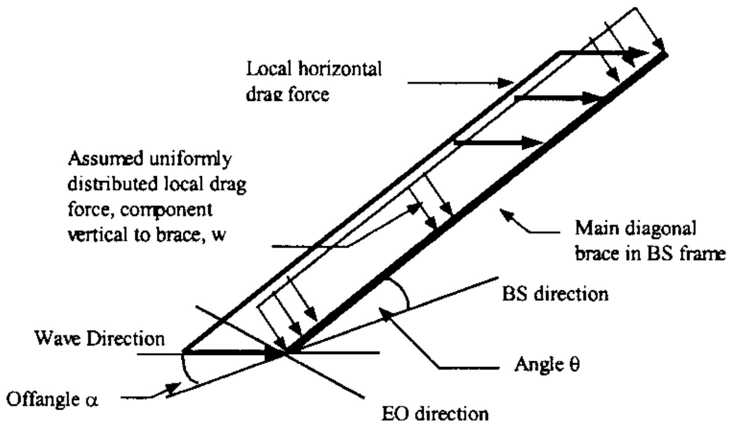
BS, EO components

BS and EO frames

Batter components

Pile Loads

Local Detailed Analysis



Effects of α on local load and capacity

For braces in EO frame:

α=90 degree, EO loading: $D_{equ} = D \cdot Sin^2\theta$

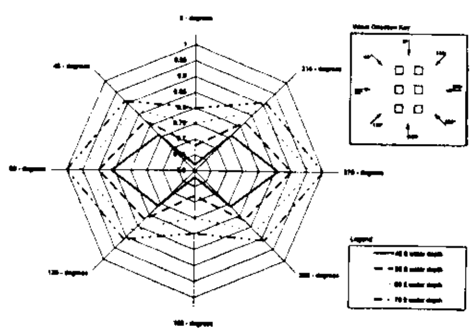
α=0 degree, BS loading: $D_{equ} = D/Sin\theta$

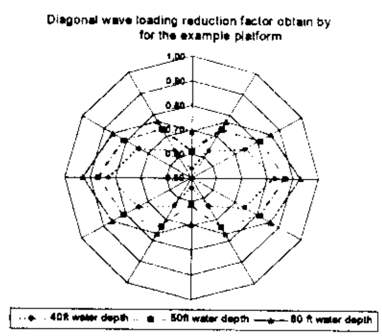
any α, diagonal loading: $D_{equ} = D(Sin^2\theta + Cos^2\theta \cdot Sin^2\alpha)^{3/2} / Sin\theta$

For braces in BS frame: $D_{equ} = D(Sin^2\theta + Cos^2\theta \cdot Cos^2\alpha)^{3/2} / Sin\theta$

$$P_u = \frac{M_u}{8\Delta_0 \left(\frac{1}{1 + 2\frac{\sin 0.5\varepsilon}{\sin \varepsilon}} \right) \frac{1}{\varepsilon^2} \left(\frac{1}{\cos \frac{\varepsilon}{2}} - 1 \right)} - \frac{w l^2}{8 \Delta_0}$$

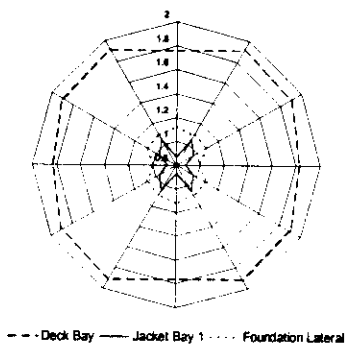
Case Study 1: Loading, Exxon Multi Jackets





Case Study 2: Capacity, SP62

Variation of Safety Indexes with respect to Offangles



	End-On	Broadside	60 Degrees	30 Degrees
Deck Bay	1.83	1.76	1.902	1.911
Jacket Bay 1	0.88	0.87	0.959	1.045
Jacket Bay 2	0.56	0.61	0.666	0.764
Jacket Bay 3	0.58	0.94	0.843	1.014
Jacket Bay 4	0.56	0.89	0.838	0.954
Jacket Bay 5	0.61	0.86	0.912	0.909
Jacket Bay 6	0.72	1.34	1.172	1.322
Foundation Lateral	0.99	1.12	1.092	1.088
Pile Compression	0.51	0.44	0.521	0.568
Pile Tension	1.04	0.93	0.897	0.963

3. Long-term Reliability

Basic Approaches:

$$P_{f\cdot accumulative} = \int_0^\infty P_{f|H_w} \cdot p_{H_w}\, dH_w = \int_0^\infty P_{f|ARP} \cdot p_{ARP}\, dt$$

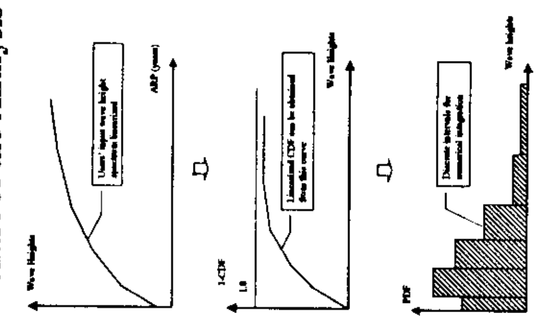
$$P_{f,accumulative} = \sum_{1}^{10000} P_{f|ARP} \cdot p_{ARP} \cdot \Delta t$$

$$P_f = 0.475 \cdot \exp(-\beta^{1.6})$$

$$P_f = 1 - 0.475 \cdot \exp(-\beta^{1.6})$$

Flowchart of the Analysis

- Flowchart of the Analysis

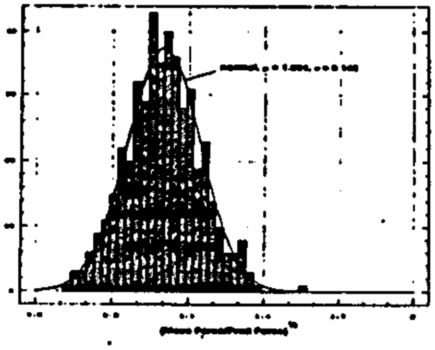


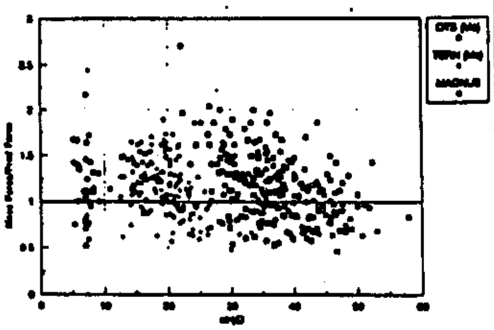
Validity of the Linearization Procedure

ARP(year)	H(ft)	P_h(theoretical)	p_h(linearized)	ΔP_h(approx)	P_h(approx)
1	25	0	0.0625	0	0
2	33	0.5	0.06	0.49	0.49
10	40	0.9	0.0375	0.34125	0.83125
20	45	0.95	0.0045	0.105	0.93625
100	60	0.99	0.00196	0.04845	0.9847
1000	70	0.999	0.00066	0.0131	0.9978
10000	75	0.9999	0.00018	0.0021	0.9999

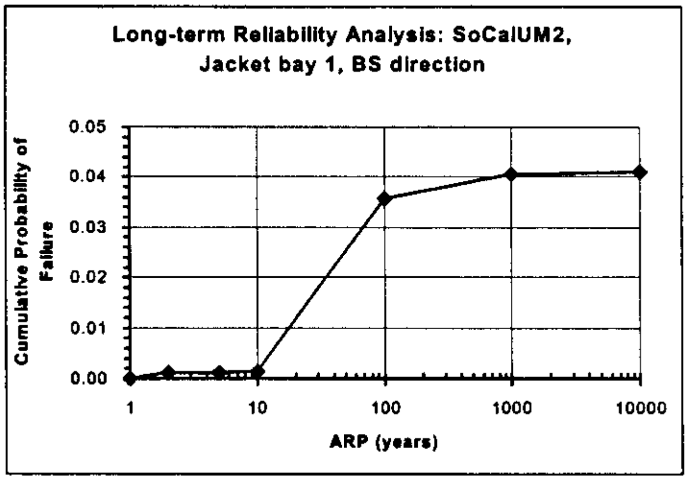
ARP(year)	H(ft)	P_h(theoretical)	p_h(linearized)	ΔP_h(approx)	P_h(approx)
1	25	0	0.0625	0	0
2	33	0.5	0.057142857	0.47857143	0.478571429
5	39	0.8	0.04	0.29142857	0.77
10	43	0.9	0.01875	0.1175	0.8875
20	47	0.95	0.006	0.0495	0.937
100	58	0.99	0.003	0.0495	0.9865
200	62	0.995	0.000818182	0.00763636	0.994136364
1000	69	0.999	0.000408333	0.0042928	0.998429167
10000	74	0.9999	0.00018	0.00294167	1.001370833

Constant COV's and Biases over Long-term Period



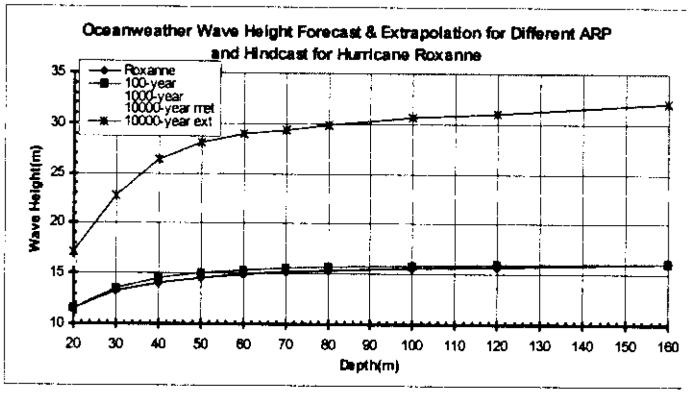


Case Study: SoCalUM2

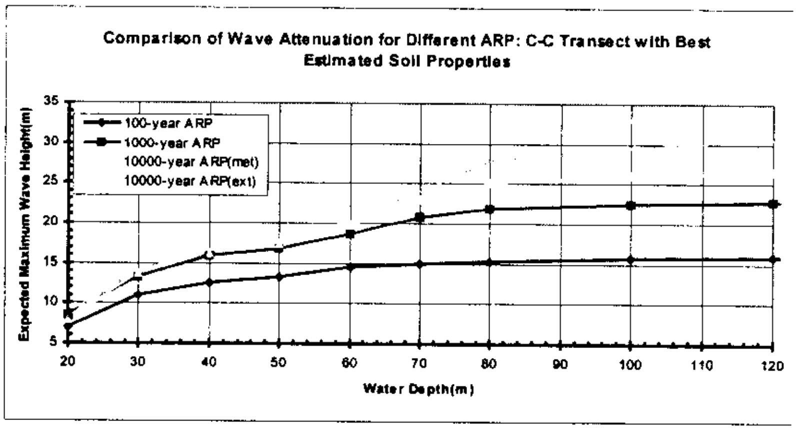


4. Truncated Wave Height Spectrum

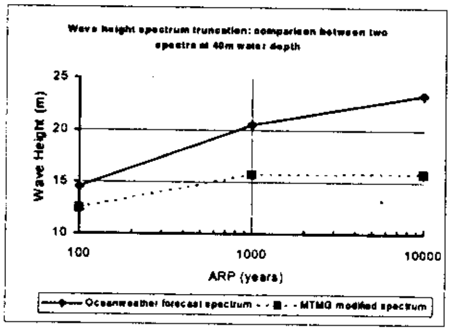
Normal Wave Height Forecast in Bay of Campeche:

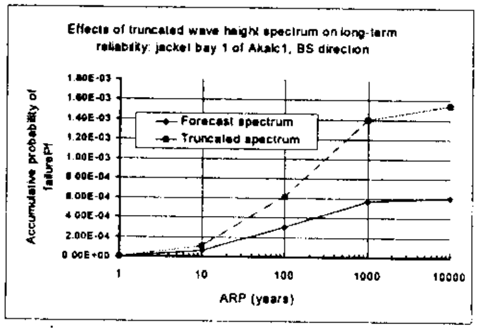


A special truncated wave height spectrum due to soft sea bottom



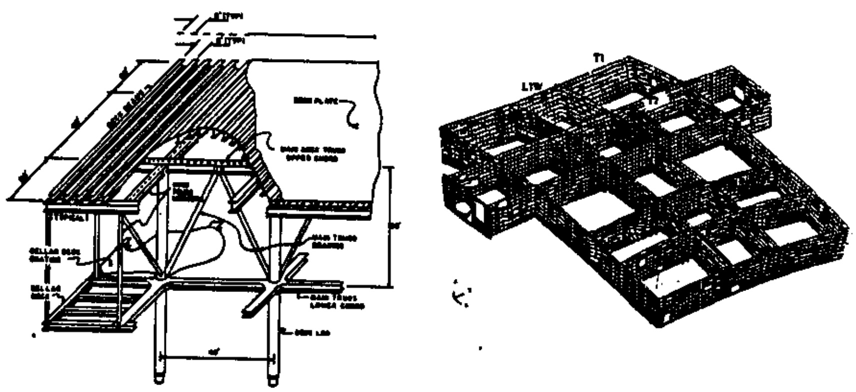
Comparison of Wave Height Spectrum and Long-term Reliabilty



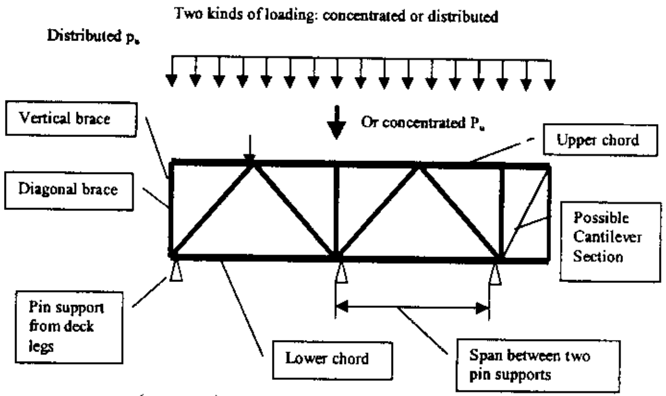


5. Deck Element Analysis

Two major kinds of platform deck structures:

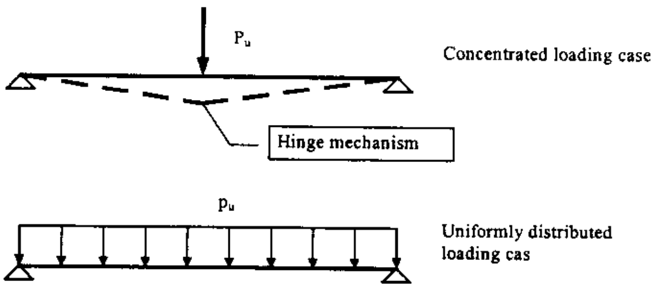


Simplified Truss Deck Model



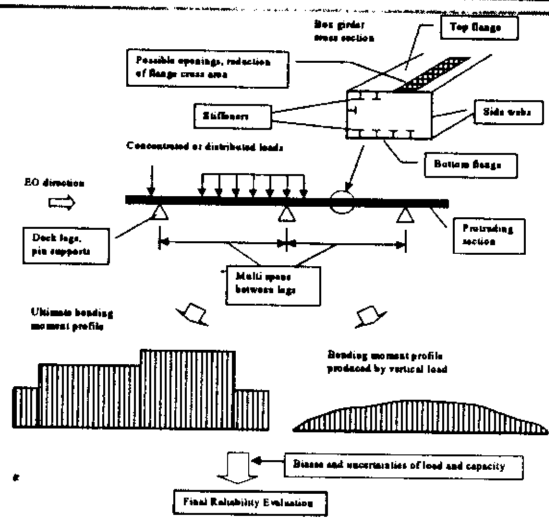
$$P_{u,j} = \sum_i \left(\frac{P_{u,MLTF}}{K_{MLTF}} \right) K_i \qquad K_i = \frac{E_i A_i \cos^2\theta}{L_i}$$

Calibration of Strength of Chords

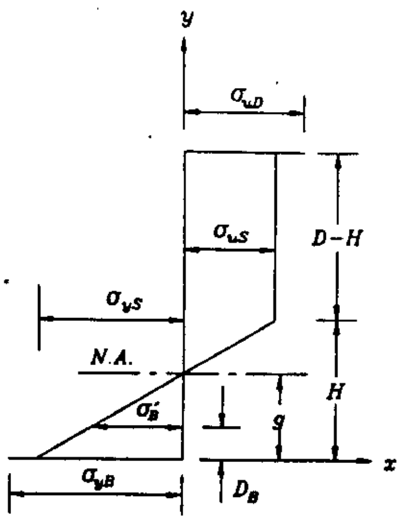


First Case: P_u =4 M_p/l; Second Case: $p_u = 8M_p/l^2$
For fixed end supports: ultimate loads doubled.

Simplified Box Girder Deck Model



Determination of the Ultimate Bending Moment



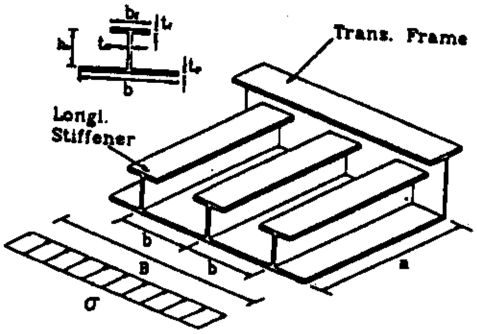
$$M_u = -A_D(D-g)\sigma_{uD} - \frac{A_S}{D}(D-H)(D+H-2g)\sigma_{uS} - A_B g\sigma_{yB}$$
$$-\frac{A_S}{3D}\left[(2H-3g)\sigma_{uS} - (H-3g)\sigma_{yS}\right]$$

$$H = \frac{C_1D + \sqrt{C_1^2D^2}}{2}$$

$$C_1 = \frac{A_D\sigma_{uD} + 2A_S\sigma_{uS} - A_B\sigma_{yB}}{A_S(\sigma_{uS} + \sigma_{yS})}$$

$$g = \frac{(C_1D + \sqrt{C_1^2D^2})\sigma_{yS}}{2(\sigma_{uS} + \sigma_{yS})}$$

Determination of Ultimate Compression Strength of Stiffened Plates



$$\sigma_u/\sigma_0 = (0.995 + 0.936\lambda^2 + 0.170\beta^2 + 0.188\lambda^2\beta^2 - 0.067\lambda^4)^{-0.5}$$

$$\sigma_0 = \frac{bt_P\sigma_{OP} + A_{st}\sigma_{OS}}{bt_P + A_{st}}$$

$$\beta = b/t_p \cdot \sqrt{\sigma_0/E}$$

$$\lambda = a/(\pi r) \cdot \sqrt{\sigma_0/E}$$

$$r = \sqrt{I/A}$$

6. Future Developments

- Update TOPCAT to Excel 97 Environments
- Revision of Data Structure in TOPCAT Excel Sheets, and Data Communication between Modules
- Transfer Complicated Subroutines into Standardized Independent Procedures
- Develop 3-D Representation of Platforms
- Case Study and Verification
- Distributed Loads and Global Torsion
- Optimal Platform Configurations

Analysis of Wave-in-Deck Forces

Screening Methodologies Project
Phase IV

Purpose of Study

- Evaluate TOPCAT calculated deck forces
- Compare with results from:
  - Model testing
  - Chevron method
  - API recommended practice
- Propose changes to TOPCAT procedure

South Timbalier 134D

- Water Depth 141 ft
- Main deck levation 180 ft
- Tests done on 1:28 scale model

Load Cases

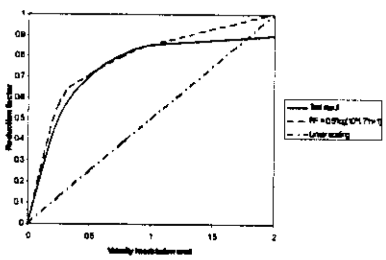
- Waves ranging from 28.5 to 48 ft
- Wave period 15.5 sec
- Two directions:
  - Broadside
  - End-on
- 45° heading not considered because of limitations in TOPCAT

Deck Force Procedures

Method	Drag Coefficient	Inundated Area	Directional Spreading Factor	Crest Velocity
Chevron	Based on empirical data from tests. Different values for broadside and end-on loading. Range of 0.6 - 1.0	Detailed space frame model. All areas normal to wave included. Crest height multiplied by 1.07.	0.95 for winter storms. 0.88 for hurricanes	Stream function theory
API	Based on density of deck equipment No difference for broadside and end-on loading. Range of 1.6 - 2.5.	Silhouette area. Leg area not included below cellar deck.	1.0 for winter storms. 0.88 for hurricanes.	Wave theory
TOPCAT	Average of value for inundated area. Value of 1 for circular surfaces, 2 for flat surfaces. Scaling down to two velocity heads below the crest	Projected area of equipment. Structure area recognizes individual members based on distance between members. Run-up zone equal to one velocity head included	0.95 for winter storms. 0.88 for hurricanes.	Wave theory. Stokes 5th order for deep water and Cnoidal theory for shallow water.

TOPCAT Modifications

- Run-up zone added
- Scaling of drag coefficient
  - Originally linear scaling
  - Logarithmic scaling found



Chevron Results

- Mean biases from 1.002 to 1.08
- COV's from 31.6 to 36.4 %
- Overall very good results
- How good will results be for other structures?

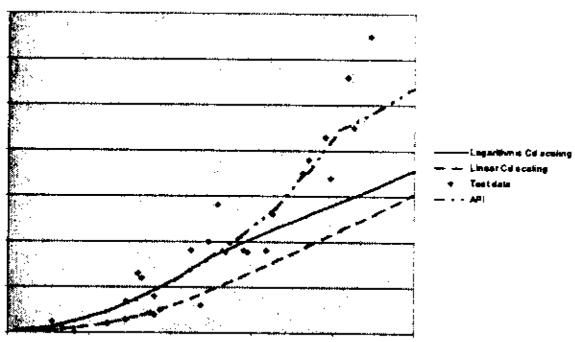
API Results

- Biases from 0.977 to 2.058
- COV's from 47.9 to 92.3 %
- Broadside results are good
- End-on results not very good

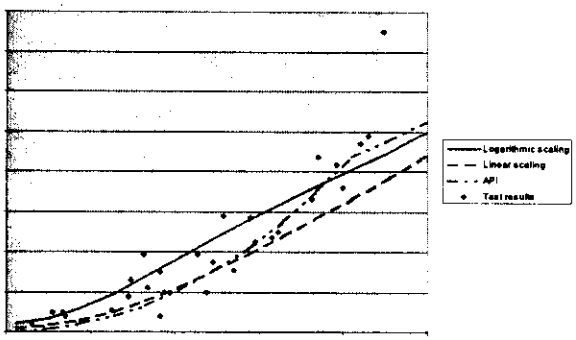
TOPCAT Results

- Results using linear scaling of drag coefficient not very good
- Better results using modified scaling
  - Biases from 0.824 to 1.31
  - COV's from 22.2 to 52.2

TOPCAT/API results



TOPCAT/API results

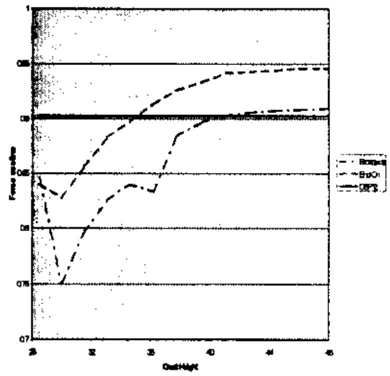


Deck-by-deck evaluation

- Big differences in results for the various decks
- Underestimation of forces for highest waves
- Scaffold deck case might indicate that test results are too sparse

Effect of DSF

- Effect of Directional Spreading Factor and drag coefficient combined
- Varies a lot from the simple DSF[2]



Summary of results

- Good Chevron results (as expected)
- API results good for broadside loading, not so good for end-on loading
- TOPCAT with modified Cd-scaling better than API

Conclusions

- TOPCAT method simple
- Not expected to give as good results as Chevron method
- A little more effort leading to better results from API to TOPCAT
- Other structures should be investigated in order to verify results

Wave Forces on a Pile

Screening Methodologies Project
Phase IV

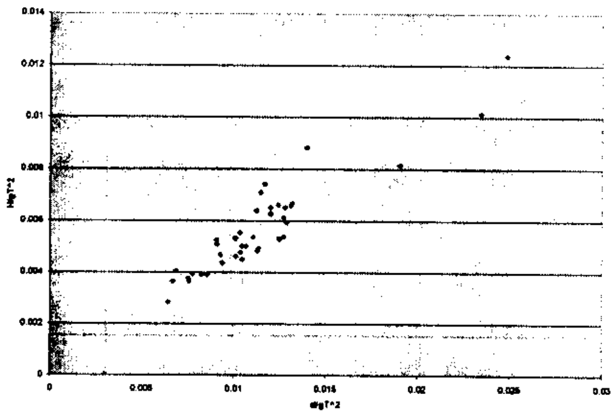
Purpose and Study

- Evaluate shallow water force procedures
- No shallow water waves in report
- Stokes 5th order theory used

Waves used in study

- Wave heigth 13.8 to 21.5 ft
- Wave period 6.4 to 12.8 sec
- Water depth 31.2 to 34.9 ft

Waves considered in study



Results of study

- Mean bias 1.16
- COV 0.69
- Biases fit lognormal distribution well